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NEW DATA ON THE PROBLEM OF AEROSOL RETENTION DURING
RESPIRATION

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[A Digest]

Research was carried out to determine: (1) the amount of aerosol condensate, (2) the amount of disintegrated aerosol particles, and (3) the relation of the charge of particles to the amount retained during respiration.

Cadmium oxide and zinc oxide were used to determine the amounts of aerosol condensate retained. Experiments were conducted on humans with smoke concentrations of 65,000 to 400,000 particles per cubic centimeter of smoke (cadmium oxide) and 40,000 to 360,000 particles per cubic centimeter of smoke (zinc oxide). A total of 139 experiments was conducted: 59 with CdO and 80 with ZnO. Retention varied from 45 to 90 percent (average of 60 percent). In all cases zinc oxide was retained to a higher degree than cadmium oxide due to the greater dispersion and particle content of zinc smoke. The theory that the charge of the particle is largely responsible for the degree of retention was suggested. Collation of data obtained in experiments with tobacco, coal, and magnesium oxide showed that the amount of retention is dependent on the depth and degree of penetration of the particles into the lungs.

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An attempt was made to determine the value of the nasal passages as filters. Results showed no difference in retention of CdO, while 3.5 to 5.5 percent more ZnO was retained in nasal inhalation than in oral inhalation.

Other studies were conducted to determine the retention of the so-called disintegrated aerosols, such as quartz dust and aluminum powder. Small particles of aluminum powder (0.3 to 1 micron) were retained to a greater degree than quartz dust particles, while the larger aluminum particles (1 to 3 microns) were retained to a lesser degree than quartz dust particles of the same size. Tests were also conducted on submicroscopic particles (less than 1 micron) at concentrations of 45,000 to 50,000 particles per cubic centimeter. Retention of aluminum was 62 percent and retention of quartz 46 percent. Comparison of data obtained showed that:

1. Submicroscopic particles of quartz are retained about 13 percent more than its smallest microscopic particles (0.3 to 1 micron)
2. Submicroscopic particles of aluminum powder were retained 9 percent more than the larger particles, and 13 percent more than submicroscopic quartz particles.

Very interesting results were obtained as a result of tests on a 1:9 mixture of aluminum and quartz. It can be said that addition of at least 10 percent of aluminum powder greatly decreased the retention of the particles making up the mixture. This opens up an interesting new field, in which retention of dangerous industrial dusts could be decreased by the addition of other substances.

An attempt was made to determine the degree of retention from the concentration of the dusts in the air. Results were rather promising, as a threefold increase in the concentration (from 50,000 to 150,000 particles per cubic centimeter) increased retention from 16 to 46 percent.

It had been suggested previously that the charge of the particle has a considerable effect on the degree of retention. Experiments were conducted in several factories where different machining processes released a considerable number of triboelectrically charged particles (friction charges) into the air of the factory. A special apparatus was developed on the basis of L. S. Borishanskiy's suggestions which incorporated a condenser, which could be charged, and an Owens counter. The amount of charged particles in the air varied from 78.9 percent ("Il'ich" Factory, where carborundum was being milled) to 45.5 percent ("Proletariy" Factory, where small porcelain articles were being ground and finished). Experiments were conducted with air containing marshallite powder and aluminum powder which was obtained from the VAMI Laboratory. In one case the retention (marshallite powder) was 52.9 percent. This consisted of only 10.5 percent uncharged particles but 74.6 percent charged particles. In the other case, general retention (marshallite powder) was 41.4 percent, which consisted of 16 percent uncharged particles and 70 percent charged particles. The former was also used in tests with aluminum dust. It was determined that the charged particles made up 83 percent of the dust which was retained.

In conclusion, the data shows that the greater part of the dusts retained is made up of particles which are less than 1 micron in size.

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